FOREIGN SUBSIDIARIES AND TECHNOLOGICAL CAPABILITIES IN THE ARGENTINEAN MANUFACTURING INDUSTRY

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1. INTRODUCTION

Subsidiaries of foreign multinational corporations (MNCs) have been central actors in the manufacturing sector of Argentina since the earliest stages of its industrialisation process, as it was the case in most of the Latin American countries. In the 1990s the presence of MNC subsidiaries in Argentina increased sharply, due to an upsurge in the inflows of foreign direct investment (FDI). This called for better grasp of the contribution of foreign subsidiaries to the local economy. In fact, after being out of the spotlight for a long period, as most academic and policy attention in Latin America turned to macroeconomic issues, concerns regarding the relation between foreign multinational corporations and technological development in host countries reappeared in the research agenda for the region in the 1990s, particularly in the cases of Argentina, Brazil and Mexico.

Within this context, this paper aims to make a contribution to further understanding of the implications of the vigorous presence foreign subsidiaries in the region to deepen and strengthen technology and knowledge base in host economies. We hold that under the knowledge economy such implications should be considered not only in terms of diffusion of technologies generated elsewhere, but also the generation of knowledge and technology locally. With few exceptions, studies about the influence of foreign subsidiaries upon Latin American industry have assumed that technological development is the local adoption and use of existing technology. From this perspective, not much attention has been paid to impacts of the foreign stake on further technological learning in the local industry. In other words, to what extent may MNC subsidiaries stimulate local industry to evolve from its status of foreign-technology user towards a more active position as an original generator of knowledge on the international technological frontier?

To reach this objective, the paper analyses the technological profiles of MNC subsidiaries in the Argentinean manufacturing industry, and compares them with those of domestic firms. We discuss the technological profile of local subsidiaries of foreign firms from the perspective of the technological capability approach[1], as it provides a useful conceptual framework on this issue, and also gives some insights into the role played by different economic agents in technological change in developing countries. Thus, by technological profile we mean the level of learning reached or technological capability accumulated by firms. The underlining argument is based on the subsidiary-driven model for the analysis of technological spillovers from MNC subsidiaries,

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[1] Drawing upon evolutionary theory, the technological capability approach emerged in the late-1970s and early-1980s through a set of empirical studies on the nature, intensity, and determinants of technological change in developing countries.

as proposed by Marin and Bell (2004 and 2005). We then hold that the impacts of FDI in host economies with regard to their technological development should be evaluated in terms of the level of technological capabilities accumulated by the MNC subsidiaries themselves. That is, the learning process of MNC subsidiaries is the main determinant of the potential for technological spillovers and technological dynamism in the recipient countries.

The methodology adopted in this paper is in line with the one proposed by Costa and Queiroz (2002) and Costa (2003) in their study on the Brazilian industry[2]. Hence, proxies for technological capabilities are developed, based on a classification of technological capabilities that emphasizes the distinction between use and generation of knowledge at firm level. As in the Brazilian study, the proxies are calculated as composite indexes by means of an innovation survey database. Here we use the second Argentinean innovation survey, which was carried out by INDEC, the Argentinean National Council of Statistics, for the period 1998-2001[3]. It is worth noticing that this survey period overlaps with the economic crisis Argentina underwent between 1999 and 2002, which can be easily capture by the negative growth rates of GDP for the years 1999 (-3%), 2000 (-0.8%), 2001 (-4.4%) and 2002 (-11.3%). The survey results were probably implied by the crisis, especially if we consider that it was followed by sharp decrease in FDI inflows to the country.

Notwithstanding the effects of the crisis over the activities of foreign subsidiaries in Argentina, it is important to mention that FDI inflows underwent a downturn all over Latin America during this period. Thus the reasons for such a downturn go beyond the Argentinean crisis. Actually, one important reason is the fact that in the second half of the 1990s the level FDI inflows were exceptionally high. Than, more than a cyclical reaction, the decrease of FDI in the region reflected the slowing down of investment opportunities represented, for instance, for the privatization process. Moreover, MNC subsidiaries have a long life in Latin America. In the case of Argentina in particular, foreign multinational corporations started to establish subsidiaries in the 1930s and even more intensively from the 1950s onwards. This lead we back to the main argument underlining our analysis: as foreign subsidiaries have been in Argentina for quite a long time, they may have developed technological capabilities which cannot have vanished completely with the crisis.

The analysis in this paper is organised into five sections apart from this introductory one. Section 2 give some further aspects of foreign MNCs' presence in Argentina, and the related issues scholars and policy makers have been concerned with. Based on the technological capability literature, Section 3 sets some conceptual parameters and presents the classification of technological capabilities that is the starting pointing for developing the indicators for the analysis proposed in this paper. Having outlined the conceptual framework, the next step is to identify out of this classification which technological capabilities can be made into proxies, and how the proxies can be computed, given the available data. These methodological aspects are described in Section 4. Adopting this methodology, Section 5 summarises the main findings which arise from the comparison between the technological capability proxies for foreign

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[2] Our original idea was for this paper was to compare the results of both Argentinean and Brazilian studies in order to identify similarities and differences with regard to the technological profile of MNC subsidiaries in both countries. For this we need to update the indexes for Brazil, which was not possible to make, giving a delay in accessing data from more recent and broader Brazilian innovation survey.

[3] INDEC, *Instituto Nacional de Estadística y Census* (www.indec.gov.ar). *Segunda Encuesta Nacional de Innovación y Conducta Tecnológica de las Empresas Argentinas* 1998 – 2001 (Serie Estudios del INDEC, number 38).

subsidiaries and domestic firms, broken down by the manufacturing sector at two-digit ISIC Rev 3 level. Section 6 contains a critical evaluation of those findings in order to draw up some concluding remarks on the role played by foreign-owned subsidiaries in terms of further technological accumulation in the Argentinean manufacturing industry. It also makes some policy remarks based on the findings.

2. SOME FACTS AND TALKS ON FDI AND ITS IMPACTS TO ARGENTINA

Argentina has been hosting subsidiaries of foreign multinational corporations since a long time. Yet, following the long economic downturn in the 1980s, the 1990s were marked by exceptionally high levels of FDI inflows into the country. In overall terms, the Argentinean appeal to the foreign investors in the 1990s was driven by liberalisation, de-regulation and macroeconomic stabilization of the local market that was potentially “enlarged” by the Mercosur. The privatisation program was another very driving for FDI into Argentina in the 1990s. According to Ernst (2005), 67% of all capital involved in the Argentinean privatisation came from abroad. This was reflected by the boom of services FDI in the country. Yet, the manufacturing industry is an outstanding destination for FDI in Argentina, in line with the tradition of the industrialisation by import substitution. In the period of 1993-2003, the average share of the manufacturing sector in the total FDI entering Argentina was 23%, peaking in 1994 (49%) and in 2003 (69%). The growth rate of FDI in the manufacturing sector between 1993 and 2000 was 73.3%, notably in the sectors of food, beverage and tobacco (40.8%), chemicals and chemicals products (98.6%) and motor vehicles and other equipment of transport (295.3%). These figures reinforce the relevance of analysing the role foreign subsidiaries play in the Argentinean technological development by looking at the manufacturing industry.

On this matter, there have been many studies analysing the benefits (and costs) of the foreign stake in terms of *inter alia* productivity, economies of scale and scope, competitiveness, exports and international integration of the Latin American countries, and the Argentinean economy in particular. It is broadly argued that MNC subsidiaries facilitate the access to international capital and technology. Indeed, since the import substitution period, FDI has been one of the main mechanisms for gaining access to industrial technology, reflecting the substantial reliance on foreign technology which has been a remarkable trait of Argentinean industrial development. Furthermore, in the 1990s foreign subsidiaries favoured an intense technological upgrading of products and productive activities as part of a broad modernization process of the local industry (Chudnovsky et al. 2005, Ernst, 2005).

This modernisation did not take place only amongst foreign subsidiaries; instead it was an outstanding process within the Argentinean manufacturing industry as a whole, involving all players, being them foreign or domestic, private or state companies. Along with the modernisation process, the local manufacturing industry underwent to deep structural changes, in which foreign subsidiaries played an important part. Foreign MNCs’ participation in such structural changes was marked not only by the modernisation, but also by vast amount of FDI in the form of merger and acquisitions (M&A). In fact, the majority of M&A-related FDI was basically acquisition of domestic firms by foreigners: between 1991 and 1996, the average share of M&D in FDI inflows to Argentina was 38.9%, and it grew to 82.3% for the period 1997-2002 (Ernst, 2005).

This scenario gave grounds for concerns regarding negative side effects of the growing presence of foreign firms in Argentina. For instance, implications of increased import levels (mainly capital goods), broader denationalization and concentration due to the acquisitions of domestic firms (especially the bigger and more dynamic ones) have been under discussion. In particular, issues about technological impacts of the growing foreign stake have been addressed. Notwithstanding their benefits in terms of modernization, it has been contended that foreign firms discontinued much of the adaptive technological efforts undertook by their local subsidiaries. This means an apparent paradox on the technological role played by foreign multinational corporations in the Argentinean industry, since at the same time that they were crucial agents for the modernization process, it seems that they started to downsize their local technological efforts, especially the more complex and creative ones, like research and development (R&D). These same concerns have been raised in the cases of other Latin American countries (Mortimore, 2000; Katz, 2000; Mortimore *et al.*, 2001; Cassiolato *et al*. 2001).

Indeed, this is a long-dated issue in the context of developing countries and in particular in Latin American. Since late-1970s, the specialised literature has argued that the adaptive of technological learning in developing countries is associated with local subsidiaries of foreign multinationals (Lall, 1992; Katz and Bercovich, 1993). A common concern comes from the fact that multinational corporations, which are the main world generators of industrial technology, tend to retain their more creative and complex technological efforts (like R&D) in the advanced part of the world, generally their home countries. This means multinational firms are prompted to "transfer" technological knowledge to developing countries, but not the process of generating new knowledge itself. This was described as a truncation of FDI-based learning process, which may hamper further technological accumulation in developing countries (Lall; 1992; 1994; 2000a; and 2000b).

Concerning this matter, an important argument held by the literature on technological capability is that developing countries should not be considered as mere receivers of technologies from the developed part of the world, given that they accumulate some capabilities at least to adapt imported technologies to local conditions. This argument has been broadly proved, particularly in the Latin American case (Katz, 1976).

Working on the same issues, there have been many studies analysing the technological spillovers from MNC subsidiaries into recipient countries. Basically, these studies try to measure the spillovers through the production function model, evaluating variation in the productivity of domestic firms that can be explained by local activities of foreign MNCs. One of the main points made out from these works is that domestic firms should have the right levels of absorptive capacity in order to benefit from the technological spillovers from local MNC subsidiaries (Narula and Marin, 2003, Chudnovsky *et al*., 2004). An argument contented by Marin and Bell (2004, 2005 and 2006) in their studies on technological spillovers in Argentina. According to these authors, the technological spillovers are higher in the cases that MNCs subsidiaries have higher technological profile.

By the same talk, we argue that the learning process that takes place within MNC subsidiaries should be central in the analysis of the impacts of FDI over recipient countries' technological development. This means FDI impacts dependent not exclusively on the technology and knowledge that MNCs (as global corporation) are willing to "transfer" to the host economy, nor on the "absorptive" capacity of domestic firms. Instead, the technological learning that takes place in the subsidiaries is crucial.

3. CLASSIFYING TECHNOLOGICAL CAPABILITY: FUNCTIONAL AND META DIMENSIONS OF LEARNING[4]

This section outlines the conceptual framework for investigating the relative contribution of foreign subsidiaries to further technological learning in Argentina. Drawing upon the technological capability approach, it presents a classification of technological capabilities, aiming to reflect both the use and generation of technology.

Technological capability is usually defined as skill**,** knowledge and experience required for a firm to achieve technological change at different levels. It is acquired and accumulated over time as technological efforts are undertaken. Such a technological accumulation is called learning process, which is simultaneous with technological changes. The kind of capability accumulated, as well as the technological change achieved depends on how explicit and purposeful those efforts are. The more explicit and purposeful the technological efforts, the deeper and more complex the capabilities accumulated and the technological change achieved (Lall, 2000a).

Although this paper is concerned with the learning process, it is useful to make some considerations regarding the originality and creativeness of the technological change achieved. Particularly helpful for our purpose is the distinction between imitation and innovation, since they are associated with use and generation of knowledge. An imitation is the use of technologies developed by external agents and already available in the market. It may be either a duplicative or creative imitation; while the former is a pure copy of technology, the latter, although basically a copy incorporates some intramural contribution in terms of improving and adapting the technology imitated. In turn, an innovation is the generation by a firm of a new process or product technology, which is introduced into the market for the first time[5] (Kim and Nelson, 2000; Bell and Albu, 1999). In this paper, innovation is taken in the strictest sense as being an innovation in relation to the international market, a true novelty at the edge of the world technological frontier.

Having made these conceptual observations, we outline the classification of technological capabilities (TCs) upon which the development of the proxies will be based (Figure 1).

This classification draws a distinction between two closely associated dimensions of technological capabilities, namely, functional and meta-capabilities. While functional capabilities facilitate activities in the productive level, meta-capabilities facilitate the dynamic of the knowledge accumulation itself. The meta-capabilities are related to the "repetition" of efforts and routines within the firm. Hence it is rather subjective, in line with the aspect of path dependence and idiosyncrasy pointed out the evolutionist literature.

It is worth mentioning that according to this classification, "complexity" is an inherent aspect of functional capabilities, since they are associated with the kind of technological change they may induce. Therefore, functional and meta-capabilities cannot be compared to one another in terms of their degrees of complexity. This means we cannot say that meta-capabilities are more complex than functional capabilities, and vice-versa.

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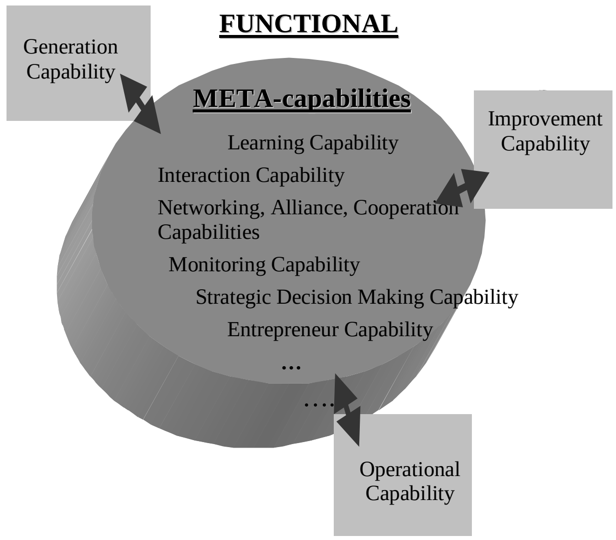
[4] A great deal of this section draws on Costa and Queiroz (2002) and Costa (2003).

[5] Without going into a complex of meanings for innovation found in the literature, it is interesting to observe that "innovation" is a relative idea. That is, innovation is always a change in relation to a "frontier", which can be the firm itself, its local competitors, its sector of activity, the country in which it is based, or the world market. This perspective has been incorporated in the design of innovation surveys' questionnaires, as it is the case of the second Argentinean innovation survey.

Figure 1 –Classification of Technological Capability and its Functional and Meta-dimension



Three kinds of functional capabilities are proposed in Figure 1: operational, improvement and generation capabilities. These are capabilities, respectively, to operate, improve and generate either product or process technologies. The criterion adopted to define these categories of capabilities is the originality and creativeness of the technological change they may influence through technological efforts. Thus, operational capabilities are related to an efficient performance of productive activities[6]. They encompass skills, knowledge and experience to search, acquire, assimilate, use, master, and make minor adaptations of product and process technologies. As such, their effects upon technological change are more associated with a duplicative imitation of technology generated by other agents and somewhat with minor creative imitation. In turn, improvement capabilities are skills and knowledge associated with major creative imitation of technologies adopted, that is, the firm's ability to improve upon technologies developed by external agents. In the case of MNC subsidiaries, these may refer to the corporation itself, being it headquarter or sister companies. As mainly creative capabilities, instead of just duplicative, they are more complex than the operational capabilities. Likewise, generation capabilities are characterised by technological creative skills and knowledge. Nevertheless, these capabilities are a further step in the learning process, since they are required for achieving more significant original results which are innovations in the strictest sense[7].

Regarding the meta-dimension of the technological learning, a few capabilities are distinguished in Figure 1: learning, interaction, networking, monitoring, strategic decision making and entrepreneur capabilities. These capabilities do not encompass all the skills and routines related

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[6] The technological capability approach has addressed these capabilities in different ways. Usually, they are defined as a set of core information required for undertaking productive activity (Lall, 1992 and 1994).

[7] Some authors have dealt with these improvement and generation capabilities as being "innovation or innovative capabilities" which are more complex capabilities as they refer to the ability to understand the principles of technology (Lall, 2000a).

to the meta-dimension of learning, yet they cover some important aspects of this process that have been emphasised by both the technological capability approach and the management literature.

Learning capability refers to knowledge in managing the learning process; therefore, it is acquired through the learning process itself[8]. Interaction capability, which overlaps with networking, cooperation and alliance capabilities, is associated with abilities to interact and exchange knowledge with external agents, and so it is accumulated through the interaction itself. The more a firm interacts with other agents, the higher its ability to interact with them[9]. The monitoring capability is the skill and knowledge required to identify, localise and keep abreast of relevant knowledge in the technological fields related to a firm's activities. Strategic decision making and entrepreneur capabilities are closely associates with one another. They refer to a firm's ability to identify and take advantage of opportunities that may benefit the firm not only in the short and medium term, but also in the long one. These capabilities are very interesting to be investigated in the case of MNC subsidiaries. In particular, it is relevant to understand how the entrepreneur ability of subsidiaries' managers, who can be local or foreigner citizens, implies the subsidiaries' learning trajectory. The competition against sister companies for corporate mandates is a good example of how entrepreneur capability can make a difference. Unfortunately we cannot cover this meta-capability in this paper, as it is probably better analysed with a case study approach.

In fact, the development of indicators for technological capability is not an easy task, as it refers to knowledge and skills that are rather subjective. Thus, the next step is to identify out of this classification which capabilities can be made into proxies by means of the second Argentinean innovation survey.

4. COMPUTING PROXIES FOR TECHNOLOGICAL CAPABILITIES: METHODOLOGICAL ASPECTS

Having outlined the analytical framework, we now proceed in this section to describe the methodology adopted for putting the analysis of technological capabilities proposed above into practice. The main objective is to develop proxies for different levels of complexity and creativeness of the capabilities accumulated, in order to analyse the role of the foreign stake in Argentinean technological learning.

The proxies are based on the second Argentinean innovation survey of the manufacturing industry for the period of 1998-2001. This second survey was carried out by INDEC, the Argentinean National Council of Statistics, in 2003. The survey questionnaire was designed according to both the Oslo and the Bogotá Manuals, which provide guidelines for innovation surveys. Therefore, the INDEC-innovation survey is a subject-based survey, collecting data on firms' innovative activities, rather than on innovations (objective approach). The sample size of the II Argentinean Innovation Survey was of 2,229 manufacturing firms. The overall response

[8] To a certain extent, several authors have acknowledged the importance of this kind of capability. For instance, Caniëls and Romijn (2001) note that the dynamic of the learning process is based not only on the accumulation of technological capabilities connected with the productive activity, but also on "an increasing capability to manage the technological learning process efficiently. This capability, the capability to learn, is built up as a by-product of the technological learning process (...)" (:18). It means, as noted by Stiglitz (1987), that "learning itself often has to be learned" (in Lall, 2000a: 17).

[9] This idea fits into the concept of "learning by interacting" introduced by Lundvall (1988).

rate was about 76%, with 1,688 valid questionnaires. The classification of economic activities adopted by INDEC was the CLANAE, which almost corresponds to the ISIC Rev-3.

Given this paper's focus on the role played by foreign subsidiaries in local technological learning, the origin of capital is the main criterion for defining the categories of analysis adopted here. The proxies are developed for both foreign subsidiaries and domestic firms. While domestic firms are those whose capital was totally owned by Argentinean citizens; foreign subsidiaries encompass firms both wholly and partially owned by non-Argentineans. We are assuming that firms partially owned by non-Argentineans have a similar technological behaviour as those wholly owned by non-Argentineans.

The reason for considering both domestic and foreign firms in the analysis is associated with the fact that the comparison of foreign with domestic is frequently made in the debate about the role played by foreign subsidiaries in host economies. There are arguments (and counter-arguments) that domestic firms are more prompt to undertake local technological efforts in a more systematic and complex basis than foreign subsidiaries; and that a strong presence of foreign multinationals can prevent domestic firms from deepening their own technological capabilities. Moreover, there have been arguments that large foreign subsidiaries operate more up-to-date and efficient plants than domestic firms.

In the studies on technological spillovers, MNC subsidiaries and domestic firms are also considered together. Yet, these studies have considered the learning process of domestic firms only, by emphasising the importance of their absorptive capacity in benefiting from spillovers from MNC subsidiaries. The learning process of the subsidiaries has been overlooked. Following the works by Marin and Bell (2004, 2005 and 2006), we argue that the technological learning of both domestic firms and, even more, subsidiaries should be investigated if one want to fully understand the impacts of FDI to the host countries' technological development. Therefore, the comparison of the technological capability of both groups of firms can bring further insights on this matter.

In addition to origin of capital, the size of firms is considered here in order to reduce distortion of the indices by aggregating small and large firms, since it is widely accepted that size matters for technological performance. Although theoretical and empirical debates are far from a consensus regarding how size impacts firm's technological behaviour, there is some agreement that smaller firms tend to undertake less systematic technological efforts (i.e. R&D). Thus, the very fact that most foreign subsidiaries tend to be rather large firms and a great deal of domestic firms are small and medium sized would create a bias into the indices. Taking these observations into consideration, we are building up indices both for domestic and foreign subsidiaries with 100 employees or over, which, therefore, excludes small and medium firms from the analysis. In fact, 250 employees is a more common cutting point to split small and medium and large firms. However, given the context of the Argentinean economy during the surveyed period, which led to an increase of employment and high rates of firms' mortality, we consider that 100 was a better cutting point.

Technological capability proxies are composed for each of these groups of firm from thirteen manufacturing sectors at two-digits ISIC Rev.3 levels. Table 1 shows the shares of each group of firms in the total sales and number of firms in each sector of activity for which the proxies are developed[10].

Table 1 – Number of firms and sales contribution (100 employees or over)

Manufacturing Sector (Description / ISIC code)	Domestic firms		Foreign Subsidiaries	
	Number	%sales	Number	%sales
Food Products and Beverage (15)	151	49	41	51
Textile, Clothing and Leather products (17, 18, 19)	82	81	14	19
Pulp and Paper (21)	17	43	11	57
Publishing, Printing and Record Media (22)	29	87	5	13
Petroleum and coal products (23)	4	5	4	95
Chemicals (incl. Drugs) (24)	42	27	54	73
Rubber and Plastic Products (25)	28	52	9	48
Non-metallic Mineral Products (26)	21	53	14	47
Basic Metals (27)	9	18	9	82
Fabricated Metal Products (exc. Machinery) (28)	21	33	13	67
Mechanical Machinery (29)	38	64	17	36
Electrical Machinery and Components (31)	10	45	6	55
Motor Vehicles (34)	12	2	24	98
Total	**469**	**34**	**229**	**66**

Source: elaborated by the authors, based on INDEC-innovation survey data base.

The proxies are calculated from micro-data and than aggregated for each category of firm and sector. The quantitative method adopted to compute the proxies is one of composite index. Following this method, fixed minimum and maximum values are established for each variable in order to normalize them according to the general formula:

$$\mathbf{Index_{ij} = [(V_{ij} - V_{j\,min})/(V_{j\,max} - V_{j\,min})]*100}$$

Where:
V_{ij} = actual value for category "i" in sector "j";
$V_{j\,min}$ = minimum value in sector "j"; and
$V_{j\,max}$ = maximum value in sector "j

This procedure makes the indices range from zero to 100, according to an attainment perspective, as they show the level reached by each category of firm in relation to a maximum value. This range is helpful to draw comparisons between the categories of firms and sectors.

Having defined the categories and instrument of analysis, the next step is to identify out of the classification suggested in the previous section which technological capabilities can be somehow measured by proxies. Table 2 presents the main information on the indices and sub-indices developed, the capability concept they are proxy for, the variables composing them and the questions from the Argentinean innovation survey that were used.

[10] See Annex to Table 1 for the shares of firms with 100 employees or over in the total innovation survey.

Table 2 –Summary: Technological Capability Proxies – index, concept, variables and questions

Indices	Sub Indices	Variables	II Argentinean Innovation Survey
Operational Capability Index (functional capabilities) Calculated as unweighted average of:	Product and Process Change Index	• Product Innovation (yes) • Process Innovation (yes)	• Question 901 on innovation attained: weighted by the 1998 and 2001 sales mean (group firms/sector)
	Organisational and Commercialisation Change Index	• Organisational Innovation (yes) • Innovation on Commercialisation (yes)	• Question 901 (as above)
	Modernisation Index unweighted average of:	• Use of systems/products, such as CNC, CAM, robots.. (15 options) • Working cells • Quality control and certified products • Adoption of ICT by firm • Use of ICT by employees	• Question 1203: answers weighted, being: Not use = -1, Use = 1, Use integrated software = 3 • Question 303: counting of answers (max.=6) • Question 905 and 908: counting of Yes (max=2) • Question 1201: counting of Yes (max.=6) • Question 1201: answers weighted, being: none=-1; less than 25%=1; between 25 and 75%=2 and more than 75%=3
	Share of technical and professional employees over total employment	• Number of technical and professional employees (with tertiary degree) • Total number of employees	• Question 301
Generation and Improvement Capability Index (functional capabilities) Calculated as unweighted average of:	Systematic Effort Index	• Number of scientists and engineers working on R&D • Number of employees in R&D	• Question 802 on professionals working on R&D in 2001 according to background (full time and partially), answers weighted by the mean of total employees of 1998 and 2001. Variable normalised by the same ratio for the US manufacturing industries • Question 801 on employees working on R&D (formally and informally) in 1998 and 2001
	World Innovation Index	• Product Innovation (new to the international market) • Process innovation (new to the international market)	• Question 901 on innovation attained: answers weighed by total number of firms that informed had achieved innovation of product and process
Interaction and Monitoring Capability Index (meta-capabilities) Calculated as unweighted average of:	Production Chain Linkage Index (weighted average)	• Source of information for innovative activities in the period 1998-01 (client, supplier and competitors) weight = 0.3 • Cooperation with external agents in the period of 1998-01 (client and suppliers) weight = 0.7	• Question 701 on the importance of different external sources of information for innovation. Answer categories: High importance, Medium importance, Low importance, Indifferent. • Question 1101 on the existence of cooperation with different external agents. Answers: "yes, there was cooperation"
	S&T System Linkage Index (weighted average)	• Source of information for innovative activities in the period 1998-01 (University and research centre) weight = 0.3 • Cooperation with external agents in the period of 1998-01 (University, technology centre, institute for technical education) weight = 0.7	• Question 701 (as above) • Question 1101 (as above)
Other indices (not proxies for technological capabilities)	MNC Link Index	• Source of information for innovative activities in the period 1998-01 (headquarter and other related firm) weight = 0.3 • Cooperation with external agents in the period of 1998-01 (headquarter and other related firms) weight = 0.7	• Question 701 (as above) • Question 1101 (as above)
	Overseas Cooperation Index	• Cooperation with external agents located abroad in the period of 1998-01, aggregated by three groups: Production Chain, S&T system, and Corporation	• Question 1101 on the geographical localisation of partners that the firm had cooperation. Answers areas Latin America, EU, US, Southeast Asia and Others.
	Cooperation Object Index	• Cooperation on R&D and design with external agents in the period of 1998-01, aggregated by three groups: Production Chain, S&T system, and Corporation	• Question 1102 according to object of interaction, (training, assistance for organisation change, tests, technical assistance, design, R&D)

Source: elaborated by the authors, based on INDEC-innovation survey data base.

The Operational Capability Index and its components

The Operational Capability Index is calculated as unweighted average of three indices (Product and Process Change, Organisational and Commercialisation Change, and Modernisation) and the share of technical and professional employees over total employment. In the case of this latter component of the index we assume that the higher the share of technical and professional employees in a firm, the higher its capability to operate the productive activity.

The three other sub-indices composing the Operational Capability index are somehow measures of the sort of technological change achieved in the period of 1998-2001. The hypothesis is that if a firm imitated a technology (making either a pure or a creative copy), it should previously have accumulated some capabilities in order to search for, acquire, assimilate, use, master and make minor adaptations of the technology. The variables we choose to compose each of these indices are taken as indicators of minor technical change, either imitation or duplicative imitation. It is worth mentioning that, in the case of the variables composing the two first indices, firms were asked whether or not they had introduced "innovation" between 1998 and 2001, and if so, whether the innovation was a novelty to the firm, to the local or to the international market. Although this last option can give some clue if the "change" introduced was in fact a true innovation, we considered only the general answer, i.e. introduction innovation, yes or not, for composing both the Product and Process Change and the Organisational and Commercialisation Change Index. As there were few answer to "innovation to the international market, we assumed that most of the innovation was basically either imitation or duplicative imitation, that is, a copy/adoption of technology developed by external agents, which in some cases has internal creative inputs to adapt and improve it. Moreover, there is a practical limitation in using the information according to the geographical scope of the innovation (local, national, international). Basically, the indices could be either sub or overestimated. The variables composing these two indices were weighted by the sales shares of companies answering "yes" in the total sales of the sector which they belong to. The maximum and minimum values were 0 and 100% respectively.

In turn, the Modernisation Index is calculated with base on a group of variables related to the adoption of systems and procedures to the operation of the productive activity. The maximum and minimum for the "yes/no" variables were 0 and 100% respectively In turn, the categorical variables (Questions 1203 and 1201) were weighted according to the level of sophistication represent by each answer category.

The Generation and Improvement Capability Index and its components

The Generation and Improvement Capabilities are made into proxy by a single index composed by the unweighted average of two indices: Systematic Effort and World Innovation Index.

The Systematic Effort Index is based on the proportion of scientists and engineers working on R&D in the total number of employees in each category of firms (domestic and foreign subsidiaries) and sector of activity (2 digit ISIC Rev.3). The maximum value for this index is provided by the international frontier, assumed here as the United States manufacturing industry. The proportion of R&D staff per total employment by the American manufacturing sectors is calculated by the National Science Foundation and is available at its website. In each sector the proportion observed in the American industry is taken as the maximum value and the minimum value is assumed as zero, that is, when there are no employees working on R&D activities. Given the attainment perspective, the Systematic Effort Index indicates the gap that has to be bridged in order to reach the state-of-the-art in technology. This is a very important aspect of this index, given that this paper is focused both on use and generation of technology. We are assuming that higher levels of scientists and engineers dedicated to R&D activities is likely to imply the accumulation of more complex and deeper capabilities, since it is a more systematic and purposeful effort.

The other component of the Generation and Improvement Capability Index is defined as the World Innovation Index. In this case use the variables from the questions on introduction (or not) of product and process innovations, but only those that were indicated as new to the international market. The assumption here is that the introduction of innovation which was a novelty to the international market is likely to reflect higher levels of technological learning reached by a firm. The variables composing this index were weighted by the sales shares of companies answering "yes" in the total sales of the sector which they belong to. The maximum and minimum values were 0 and 100% respectively.

Proxies for some meta-capabilities: monitoring and interaction capabilities

In addition to the proxies for functional technological capabilities, as described above, we developed a single proxy for the interaction and the monitoring capabilities, which according to our classification are meta-capabilities. This index is composed by unweighted average of two sub-indices: the Production Chain Linkage Index and S&T System Linkage Index. In the first two groups of external agents are considered: client and supplier; and in the latter the agents are: university, technology centre, and institute for technical education. The assumption here is that by make use of external sources of information for technological change, and especially by cooperating with external agents, a firm is likely to have previously accumulated some capabilities in order to identify, acquire and assimilate technology and knowledge from external sources, and interact and dialogue with external agents. In both cases, reflecting higher levels of learning and potential for an upward technological trajectory.

Each of the sub-indices (Production Chain and S&T Linkage) is composed by weighted average of variables on external sources of information for technological change (weight 0.3) and on cooperation with external agents (weight 0.7). With regard to the external sources of information, surveyed firms were asked to classify each of the listed sources according to its level of importance, being four answer categories: high, medium, low and indifferent. The information adopted is the difference between the sum of firms that classified each source as "high" and "medium", and the sum of firms that classified it as "low" and "indifferent". The difference was thus weighted by the total number of firms in the corresponding group of firms and sector of activity. The minimum and maximum values are, respectively, 0 and 100%. In the case of cooperation, the variable adopted was the existence ("yes" answer) of cooperation with external agents, weighted by the number of firms in each group and sector of activity.

Some complementary indices: MNC link, Overseas cooperation and cooperation object

The indices describe above, in particular the ones on interaction capabilities, are complemented by three other indices: MNC Link, Overseas Cooperation and Cooperation Object. The first one is calculated only for the foreign subsidiaries, and is intended to give further insights on their interaction with the corporation to which they belong to. It is composed by the same criterion as the Production Chain and S&T System Indices, using the answer categories: headquarter and other related firms (assumed here as sister companies, that is, other subsidiaries of the same corporation).

The Overseas Cooperation Index is calculated as the share of cooperation with external agents located overseas on the total cooperation with external agents. It is aimed to capture the importance of interaction with agents located abroad in relation to those based in Argentina, that is, within the Argentinean innovation system.

The Cooperation Object Index is calculated by the share of cooperation on R&D and design on the total cooperation, and is composed for three groups of agents: production chain, S&T system and corporation (only for the case of foreign subsidiaries). Giving the complexities involving in establishing cooperation on R&D and design, it is assumed that the higher the share of cooperation on these activities, the higher a firm's ability to interact.

5. MAIN FINDINGS ON THE TECHNOLOGICAL PROFILE OF MNC SUBSIDIARIES AND DOMESTIC FIRMS

This section presents the main findings arising from the application of the methodology previously described. In accord with this paper's focus on the participation of foreign capital in Argentinean learning, a comparison is drawn between technological capability proxies for foreign subsidiaries and domestic firms, aiming at generating clues about the relative contribution made by the former to further technological development.

Tables 3, 4 and 6 show the TC-proxies for foreign subsidiaries and domestic firms broken down into thirteen manufacturing sectors[11]. Considering the sectors as a whole, MNC subsidiaries score better than domestic firms on the functional capabilities indices: 40 against 55 on the Operational Capability Index; and 10 versus 17 on the Generation and Improvement Capability Index. This leading position by foreign subsidiaries is again observed in most of the sectors considered separately. On the meta-capability indices, the two groups of firms score rather the same: 53 against 52 on the Productive Chain Linkage; 32 versus 34 on the S&T System Linkage; and then 53 against 52 on the Interaction Capability Index. Let us now comment on some outstanding aspects of each capability proxy.

Starting with the Operational Capability Index, in general terms both foreign subsidiaries and domestic firms score at relatively low to medium levels (Table 3). This is intriguing result, giving the strong modernization process of the Argentinean industry that took place during the 1990s, especially between 1993 and 1997. The modest levels of operational capability suggested by the index are likely to be associated with the fact that the II INDEC-innovation survey refers to the period 1998/2001, which encompasses the peak time of the Argentinean crisis. Under the crisis, both domestic and foreign subsidiaries were probably not willing to invest in the adoption of new technologies, not in terms of products and process, nor in terms of modernisation of their production units. Yet, one may argue why the modernisation process of the years immediately before the crisis is not reflecting more robust levels of operational capabilities? Giving learning, i.e. accumulation of technological capabilities, requires continuous efforts to move forward, it is reasonable to argue that there was not enough time for the consolidation of the efforts made during the modernisation. Moreover, the lack of investments (and even disinvestments) due to the

[11] See also the Annex to Table 3 and the Annex to Table 4.

crisis, is likely to had contributed to a deterioration of capabilities accumulated in previous periods, particularly that just before the crisis. Thus, despite the relatively high level of maturity of Argentinean industry, the crisis was deep enough to negatively impacts firms' ability to efficiently use technologies generated elsewhere, that is, to imitate.

Table 3 –Operational Capability Index **(Range 0-100)**

Manufacturing Sector (Description / ISIC code)	Domestic Firms	Foreign Subsidiaries
Food Products and Beverage (15)	36	52
Textile, Clothing and Leather products (17, 18, 19)	32	35
Pulp and Paper (21)	48	57
Publishing, Printing and Record Media (22)	43	45
Petroleum and coal products (23)	62	55
Chemicals (incl. Drugs) (24)	52	56
Rubber and Plastic Products (25)	44	52
Non-metallic Mineral Products (26)	38	53
Basic Metals (27)	48	64
Fabricated Metal Products (exc. Machinery) (28)	46	47
Mechanical Machinery (29)	55	57
Electrical Machinery and Components (31)	53	48
Motor Vehicles (34)	38	68
Total	**40**	**55**

Source: elaborated by the authors, based on INDEC-innovation survey data base.

This seems to have been the case of both domestic and foreign subsidiary firms, as in overall terms the scores of both groups are modest. Also, although the latter perform better than the first in eleven out of the thirteen sectors, the differences between the two groups of firm are not very significant when the sectors are considered individually. This suggests foreign and domestic firms have locally accumulated similar levels of operational capabilities. The only exception seems to be in the Motor Vehicles sectors. What is probably related to the fact that this is a sector dominated by foreign subsidiaries, especially car makers: foreign subsidiaries responded for 98% of the sales of sampled firms from this sector (Table 1). In fact, the score of 68 by foreign subsidiaries in the Motor Vehicles industry is the highest observed on the operational capability index. This is probably reflecting the importance of the automotive industry in the pattern of specialisation of the Argentinean industry. A point confirmed by the relatively high scores of other important sectors in the Argentinean manufacturing industry:

- Pulp and paper (subsidiaries, 57);
- Petroleum and coal products (domestics, 62 and subsidiaries, 55);
- Chemicals (subsidiaries 56);
- Basic Metals (subsidiaries, 64); and
- Mechanical Machinery (subsidiaries 57).

It is interesting to note that it seems sector's technological intensity and level of operational capability accumulated are not related to one another, as the sectors above are basically medium to low tech industries. Although it is worth mentioning that there are some high-tech segments within these sectors, such as pharmaceutical in the chemicals industry.

The low levels of operational capability, and relatively broad difference between domestic and subsidiaries firms in the Food and Beverage sector is also at least curious, giving this is a very important industry in the Argentinean economy. The higher score observed amongst foreign subsidiaries can be explained by the fact they are larger than domestic firms: while 151 domestic firms accounted for 49% of the sector's total sales, 41 foreign subsidiaries accounted for 51% (Table 1).

Looking at the Generation and Improvement Capability Index, the figures indicate a slightly modest accumulation of deeper and more complex technological capabilities, placing Argentinean industry far from the frontier of technological knowledge (Table 4). This is likely to be related to the adaptive learning involved in using imported technologies, which is a remarkable trait of technological development in Argentina.

Table 4 –Generation and Improvement Capability Index **(Range 0-100)**

Manufacturing Sector (Description / ISIC code)	Domestic Firms	Foreign Subsidiaries
Food Products and Beverage (15)	14	25
Textile, Clothing and Leather products (17, 18, 19)	11	23
Pulp and Paper (21)	15	12
Publishing, Printing and Record Media (22)	11	23
Petroleum and coal products (23)	19	2
Chemicals (incl. Drugs) (24)	19	25
Rubber and Plastic Products (25)	18	19
Non-metallic Mineral Products (26)	8	16
Basic Metals (27)	23	13
Fabricated Metal Products (exc. Machinery) (28)	19	4
Mechanical Machinery (29)	13	14
Electrical Machinery and Components (31)	9	11
Motor Vehicles (34)	20	11
Total	**10**	**17**

Source: elaborated by the authors, based on INDEC-innovation survey data base.

Moreover, like in the operational capability, it appears that the score levels are more associated with the specialisation patterns of the Argentinean manufacturing industry, than to sectors' technological intensity: the sectors where higher scores are observed are those of industrial commodities, the most dynamics in the Argentinean industry, and hence, not by chance, the main recipients of foreign direct investments. In fact, this is reflected by the fact that most of the thirteen sectors we have included in our analysis are rather medium to low tech sectors. High-tech sectors like computing, electronic materials, and telecom equipments, medical, precision and optical instruments had to be left apart from this paper as the number of firms was either too low or just because there were no firms with 100 employees or more in the sample. Also, it is important to observe that sectors that at the aggregated level are normally considered as low-tech may encompass highly dynamic segments. The Food and Beverage is a good case in point. In spite of being a labour-intensive sector, characterised by simple technologies, it also includes segments like the one of modern processed food, in which sophistication, advertising and differentiation matter. This is probably the reason why this sector, along with the Chemicals one, shows the highest score among all sectors: 25, in both cases by foreign subsidiaries.

Overall, foreign subsidiaries appear to perform better than domestic firms in locally accumulating more complex capabilities, though at low levels: their scores being 17 and 10, respectively. These results seem to run counter to the arguments supporting the idea that domestic firms are more prompt to undertake local technological efforts on a systematic and complex basis than foreign subsidiaries. Actually, the figures appear to point in the opposite direction, as domestic firms perform better in only four out of thirteen sectors.

The figures in the Motor Vehicles deserve further comments. Contrasting with the situation observed in the Operational Capability Index, domestic firms scores better than foreign firms: 11 the latter and 20 the first. This may reflect a strong reliance of foreign subsidiaries on their headquarters. That is, a great of the investments on modernisation of products and production activities might depend on corporate technology and expertise. Furthermore, the automotive industry represents one of the sectors that have taken the most advantage in optimise their activities within the Mercosur. During the crisis in Argentina, Brazil was consolidated as regional headquarter by the majority of car makers and big suppliers (mainly those provide complete auto systems) located in the region. As illustrated by Table 5 the links between the foreign subsidiaries from the Motor Vehicle sector and their corporation (headquarter and sister companies) are quite high. Moreover, a great deal of the cooperation established by foreign subsidiaries from this sector was with their corporation, hence outside Argentina.

Table 5 –Foreign subsidiaries: link and cooperation with the corporation (Range 0-100)

Manufacturing Sector (Description / ISIC code)	MNC Link	R&D/Design Cooperation
Food Products and Beverage (15)	57	53
Textile, Clothing and Leather products (17, 18, 19)	34	14
Pulp and Paper (21)	69	75
Publishing, Printing and Record Media (22)	56	-
Petroleum and coal products (23)	82	29
Chemicals (incl. Drugs) (24)	61	58
Rubber and Plastic Products (25)	71	52
Non-metallic Mineral Products (26)	65	37
Basic Metals (27)	57	50
Fabricated Metal Products (exc. Machinery) (28)	58	50
Mechanical Machinery (29)	58	64
Electrical Machinery and Components (31)	48	67
Motor Vehicles (34)	65	64
Total	58	55

Source: elaborated by the authors, based on INDEC-innovation survey data base.

The analysis of the interaction and monitoring capability index can bring some further insights on this matter (Table 6). The figures illustrate a rather narrow learning in interacting and keeping abreast with other local agents, especially in the S&T system. There are only a few instances in which the indices are scored well above the overall mean, though in modest levels. The Petroleum and Coal Products sector is the most notable example of this. Overall and both on the Productive Chain and S&T System Linkage indices, foreign subsidiaries and domestic firms have high scores.

As expected, the interaction within production chain is higher than with S&T system overall and in all sectors consider separately. This points to the well reported weakness of the innovation systems in Latin American countries, that is, the lack of interaction between firms, mainly from the private sectors, and university and research institutes.

The meagre scores on Interaction Capability corroborate the low levels of Generation and Improvement Capabilities (particularly the S&T Linkage Index) and the relatively high levels of Operational Capabilities (higher level of interaction within production chain, i.e. clients and suppliers).

Table 6 – Interaction and Monitoring Capability Index and its components: the Productive Chain and S&T System Linkage Indices (Range 0-100)

Manufacturing Sector (Description / ISIC code)	Productive Chain		S&T .System		Interaction Capabilities	
	DOM	FOR	DOM	FOR	DOM	FOR
Food Products and Beverage (15)	48	44	30	33	39	39
Textile, Clothing and Leather products (17, 18, 19)	48	52	22	44	35	48
Pulp and Paper (21)	59	41	38	35	49	38
Publishing, Printing and Record Media (22)	56	32	28	12	42	22
Petroleum and coal products (23)	65	63	63	62	64	62
Chemicals (incl. Drugs) (24)	51	48	42	35	47	41
Rubber and Plastic Products (25)	62	76	35	50	49	63
Non-metallic Mineral Products (26)	48	52	39	33	44	42
Basic Metals (27)	52	60	45	36	49	48
Fabricated Metal Products (exc. Machinery) (28)	65	58	25	32	45	45
Mechanical Machinery (29)	62	51	44	34	53	43
Electrical Machinery and Components (31)	71	58	33	16	52	37
Motor Vehicles (34)	72	64	21	31	46	47
Total	**53**	**52**	**32**	**34**	**43**	**43**

Source: elaborated by the authors, based on INDEC-innovation survey data base.

Comparing domestic and subsidiaries firms, the overall figures suggest no differences between these two groups in terms of their abilities to interact: both groups score 43 in the Interaction Capability. This similar pattern is observed in most of the sectors considered separately. However, it is interesting to notice that in the case of foreign subsidiaries, part of interaction capture by the index is not taking place within the Argentinean innovation system. As already mentioned above, foreign subsidiaries present high levels of linkage with their corporation. The Petroleum and Coal Products industry is a good example: it shows the highest score in the MNC Link Index.

These findings seems to corroborate observations made in the specialised literature that since the 1990s subsidiaries of multinational corporations located in Argentina have tended to rely more on technological resources from parent firms, particularly for modernisation of process and product portfolio, while have decreased local technological efforts. Furthermore, giving that the ability to interact is crucial to integrate and benefit from spillovers, the overall low scores on the Interaction and Monitoring capabilities and the high levels of links of subsidiaries with their corporation suggest may negatively impact the potential for technological spillovers in Argentina.

6. CONCLUDING REMARKS AND SOME POLICY IMPLICATIONS

In the previous section we compared the technological profile of foreign subsidiaries with that of domestic firms, in order to get some clues on the technological impacts of vigorous FDI inflows in the Argentinean manufacturing industry. In terms of diffusion of technologies generated elsewhere, foreign subsidiaries seems to have been playing an important role. Yet, the results are not so clear when the local generation of knowledge and technology is considered.

In general terms, the analytical exercise made here suggest reasonable development of operational capabilities, coupled with shallow interaction, monitoring, improvement and generation capabilities both by foreign subsidiaries and domestics firms. In other words, the findings suggest the accumulation of substantial capabilities for using existing technologies, but only meagre capabilities for locally generating new ones.

With reference to operational capability, the impacts of the crisis with regard to technological learning seem to have been negative for both groups of firms. Although the figures for operations capabilities were higher than for the others, they were not impressive. The lack of investments due to the crisis is likely to have had contributed to a deterioration of capabilities accumulated in previous periods. Thus, despite the fact the Argentinean industry is quite mature, the crisis was deep enough to negatively impacts firms' ability to efficiently use technologies generated elsewhere. In the case of the foreign subsidiaries, their long-timed presence in Argentina seems to have been important, as they scored at similar levels as domestic firms, and in some cases even higher.

Concerning improvement and generation capabilities, the figures pointed to a slightly modest accumulation of deeper and more complex technological capabilities, confirming the well claimed "adaptive" trait of technological learning in Latin America. It is interesting and intriguing that foreign subsidiaries show higher scores than domestic firms. These results seem to run counter to the arguments supporting the idea that domestic firms are more prompt to undertake local technological efforts on a systematic and complex basis than foreign subsidiaries. Actually, the figures appear to point in the opposite direction, as domestic firms perform better in only four out of thirteen sectors. Hence, rather than represent strength of foreign subsidiaries, in relation to domestic firms, these figures may be revealing a weakness of the latter in moving forward in the technological learning process. A weakness probably worsened by the difficult to survive under the crisis context.

In the other hand, the figures give little clue on whether or not foreign subsidiaries have been discontinuing their local technological efforts, especially the more complex and creative ones, like R&D. However, the close ties of foreign subsidiaries with their corporation, and the effects the crisis may have had over their learning trajectory call for caution, and further investigation. From one perspective, this finding may confirm the concerns from the 1970s and 1980s that there is an intrinsic limitation of FDI-based learning process, as multinational corporations tend to concentrate the generation of their more precious assets (i.e. the technological knowledge) at home or in a few developed countries. The overall low scores on the Interaction and Monitoring capabilities coupled with the high levels of links of subsidiaries with their corporation reinforce this concern, as the ability to interact is crucial to both learn and benefit from spillovers.

Important implications for policy arise from the above. First, despite some drawbacks in the learning trajectory of foreign subsidiaries due to the Argentinean crisis, these firms seems to play an important role in the local system of innovation, as suggested by their relative strength on the functional capability indices. This means that a deeper understanding of the technological capabilities of MNC subsidiaries is important as far local government want to maximize positive impacts of the presence of foreign firms, while minimizing the risks of negative outcomes. More specifically, it is crucial to understand the impacts of the “foot loose” aspect of foreign direct investment, particularly during economic crisis, over the accumulation of technological capabilities within MNC subsidiaries. Second, the fragility of domestic firms, particularly with reference to more complex capabilities, must be addressed by policy makers. On this matter, it is important to take into account that domestic firms have to face specific market failures, as they draw upon different market factors, particularly those of capital and technology, than foreign subsidiaries do. This must have been crucial during the crisis for both groups of firms: the domestic ones by having more difficult to survive and the foreign subsidiaries by having the possibility to rely on their headquarters.

In general, the results also help to makes the case for strategic FDI promotion policy in order to target new investments into more complex activities and mainly to induce already established firms to strengthen and deepen the technological capabilities in their local subsidiaries. More specifically, the argument hold here that the technological profile of subsidiaries is crucial in defining their potential to generate spillovers is particularly relevant for policy makers in host economies.

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ANNEXES – COMPLEMENTARY TABLES

Annex to Table 1 – Shares of firms with 100 employees or over in the total innovation survey (In %)

Manufacturing Industry (ISIC Rev. 3 code and description)	Number of Firms			Sales98			Sales01		
	DOM	FOR	TOT	DOM	FOR	TOT	DOM	FOR	TOT
15 – Food Products and Beverage	43	12	55	49	48	97	45	50	95
16 - Tobacco products	56	22	78	4	95	100	5	95	100
17 – Textile	34	6	41	61	14	75	59	15	75
18 – Clothing	31	4	35	60	8	68	56	7	63
19 – Leather products	37	7	43	79	15	94	69	25	94
20 – Wood products	31	5	36	62	31	93	59	31	90
21 – Pulp and Paper	34	22	56	41	54	95	39	53	92
22 – Publishing, Printing and Recorded Media	34	6	40	79	11	90	76	11	87
23 – Petroleum and coal products	33	33	67	5	94	99	5	95	99
24 - Chemicals (incl. Drugs)	25	32	56	25	70	95	26	67	94
25 – Rubber and Plastic Products	30	10	40	42	38	80	37	37	74
26 – Non-metallic Mineral Products	24	16	40	46	41	87	47	42	89
27 – Basic Metals	19	19	38	17	79	97	17	80	97
28 – Fabricated Metal Products (exc. Machinery)	25	15	40	27	59	87	31	57	87
29 – Mechanical Machinery	27	12	39	55	29	84	53	31	84
30 – Office Machinery, computing	-	-	-	-	-	-	-	-	-
31 – Electrical Machinery and Components	16	9	25	29	37	66	27	32	59
32 – Electronic Material and Telecom Equipment	-	40	40	-	87	87	-	93	93
33 – Medical, Precision and Optical Instruments	22	-	22	57	-	57	57	-	57
34 – Motor Vehicles	17	34	51	2	95	98	2	95	97
35 – Other Transport (aircraft, shipbuilding, etc.)	20	5	24	47	31	78	38	36	74
36 – Furniture, manufacturing, nec	21	5	26	36	28	64	32	35	67
Total Manufacturing	**30**	**14**	**44**	**32**	**62**	**94**	**31**	**62**	**93**

Source: elaborated by the authors, based on INDEC-innovation survey data base.

Annex to Table 3 – Operational Capability Index and its Components: Product and Process Change, Organisational and Commercialisation Change and Modernisation Indices, and the share of technicians and professionals over total employees (Range 0-100)

			InOrcCml.		Modern		%Tec&Prof		Oper.Index 2	
Manufacturing Sector (Description / ISIC code)	**DOM**	**FOR**	**DOM**	**FOR**	**DOM**	**FOR**	**DOM**	**FOR**	**DOM**	**FOR**
Food Products and Beverage (15)	49	71	38	40	29	37	26	58	36	52
Textile, Clothing and Leather products (17, 18, 19)	45	43	28	37	24	34	31	25	32	35
Pulp and Paper (21)	65	82	47	59	35	40	45	49	48	57
Publishing, Printing and Record Media (22)	52	40	28	40	29	30	65	72	43	45
Petroleum and coal products (23)	75	63	75	38	49	46	50	72	62	55
Chemicals (incl. Drugs) (24)	69	66	40	47	40	45	59	67	52	56
Rubber and Plastic Products (25)	66	61	39	50	37	43	35	53	44	52
Non-metallic Mineral Products (26)	60	79	26	43	35	46	31	43	38	53
Basic Metals (27)	67	94	44	72	45	45	37	44	48	64
Fabricated Metal Products (exc. Machinery) (28)	69	50	40	62	36	41	38	34	46	47
Mechanical Machinery (29)	83	71	50	50	41	48	48	58	55	57
Electrical Machinery and Components (31)	85	67	50	33	46	57	33	35	53	48
Motor Vehicles (34)	58	77	29	67	33	57	33	70	38	68
Total	57	68	36	50	32	43	34	58	40	55

Source: elaborated by the authors, based on INDEC-innovation survey data base.

Annex to Table 4 – Generation and Improvement Capability Index and its Components: Systematic Technological Effort Index and World Innovation Index **(Range 0-100)**

Manufacturing Sector (Description / ISIC code)	Systematic Technological Efforts Index		World Innovation Index		Generation and Improvement Capabilities Index	
	DOM	**FOR**	**DOM**	**FOR**	**DOM**	**FOR**
Food Products and Beverage (15)	9	19	18	31	14	25
Textile, Clothing and Leather products (17, 18, 19)	14	16	7	30	11	23
Pulp and Paper (21)	**20**	18	9	6	15	12
Publishing, Printing and Record Media (22)	6	**20**	17	25	11	23
Petroleum and coal products (23)	**22**	3	17	0	19	2
Chemicals (incl. Drugs) (24)	13	18	24	32	19	25
Rubber and Plastic Products (25)	**28**	19	8	18	18	19
Non-metallic Mineral Products (26)	8	10	8	23	8	16
Basic Metals (27)	**47**	8	0	18	23	13
Fabricated Metal Products (exc. Machinery) (28)	**25**	7	14	0	19	4
Mechanical Machinery (29)	6	11	21	17	13	14
Electrical Machinery and Components (31)	7	10	12	13	9	11
Motor Vehicles (34)	11	5	29	16	20	11
Total	**5**	**10**	**16**	**24**	**10**	**17**

Source: elaborated by the authors, based on INDEC-innovation survey data base.